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Root, Tuber and Banana Food System Innovations

Value Creation for Inclusive Outcomes

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Chapter 3
Scaling Readiness: Learnings from Applying a Novel Approach to Support Scaling of Food System Innovations

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Abstract Scaling of innovations is a key requirement for addressing societal challenges in sectors such as agriculture, but research for development programs struggles to make innovations *go to scale*. There is a gap between new complexity-aware

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scientific theories and perspectives on innovation and practical approaches that can improve strategic and operational decision-making in research for development interventions that aim to scale innovations. To bridge this gap, Scaling Readiness was developed. Scaling Readiness is an approach that encourages critical reflection on how ready innovations are for scaling in a particular context for achieving a particular goal and what appropriate actions could accelerate or enhance scaling to realize development outcomes. Scaling Readiness provides decision support for (1) characterizing the innovation and innovation system; (2) diagnosing the current readiness and use of innovations; (3) developing strategies to overcome bottlenecks for scaling; (4) facilitating multi-stakeholder negotiation and agreement; and (5) navigating the implementation process. This chapter explains how Scaling Readiness was used in the CGIAR Research Program on Roots, Tubers and Bananas (RTB) and describes how Scaling Readiness informed the design and management of the RTB Scaling Fund, an instrument for identifying and nurturing scaling-ready innovations. We introduce the key principles and concepts of Scaling Readiness and provide a case study of how Scaling Readiness was applied for scaling a cassava flash dryer innovation in different countries in Africa and Central America. The chapter concludes with a reflection and recommendations for the further improvement and use of Scaling Readiness.

3.1   Scaling of Innovation and Scaling Readiness

Innovation and the use of innovations at scale form an important element for achieving the Sustainable Development Goals (SDGs). The international community invests significant resources in the design and testing of innovations to overcome key challenges such as food insecurity, malnutrition, and environmental degradation. Many of those innovations start as bright ideas that are consequently developed in controlled conditions, to be tested with farmers and other end users. Although initial results and testing are often promising, relatively few lead to the desired positive impact at scale (Woltering et al. 2019). The agricultural research for development (AR4D) sector, in which the CGIAR is an important player, has been struggling with the question of how to best nurture impactful innovation and scaling pathways (Leeuwis et al. 2018).

   One of the main reasons why innovations do not lead to impact at scale is that ideas about how scaling happens are not realistic. The notion of "find out what works and do more of the same" (Wigboldus et al. 2016) does not take into account the complex and diverse biophysical, socioeconomic, and political contexts that shape agriculture across the globe and limit the effectiveness of one-size-fits-all approaches (Hammond et al. 2020). Furthermore, research organizations often focus on technological innovations and pay less attention to the behavioral, organizational, and institutional changes that are needed to enable the effective use of technology (Schut et al. 2016). In addition, we observe that R4D interventions often see scaling as something that happens at the end of a short-term project or

program as opposed to long-term systemic change processes and that scientists have limited capacities to shape impactful processes and partnerships needed for the scaling of innovations (Schut et al. 2020).

Revealing misconceptions and bottlenecks to the scaling of innovations, and supporting the development and implementation of effective strategies to overcome them, inspired the development of Scaling Readiness. In this chapter, the term "Scaling Readiness" (capitalized) is used as a brand name for the decision-support process that we have developed and as a key concept and metric that scores the maturity and scalability of an innovation (not capitalized).

The notion of "readiness" refers to whether an innovation has been tested and validated for the role it is intended to play in a specific context. The concept resonates with levels of technology readiness that have been proposed by the National Aeronautics and Space Administration (NASA) of the United States, the European Commission (EU), and scholars in technology studies who assess advancements in technology development, commercialization, and transition pathways (Verma and Ramirez-Marquez 2006; European Commission 2014; Kobos et al. 2018).

Scaling Readiness builds on the key principles of Agricultural Innovation Systems (AIS) thinking (Spielman et al. 2009; Hall and Clark 2010; Hounkonnou et al. 2012). Innovation systems are the interlinked set of people, processes, assets, and social institutions that enable (or constrain) the development and scaling of new technologies, products, practices, services, and solutions to deliver impact. A key lesson from conducting innovation systems research in the AR4D sector was that complexity-aware approaches (such as AIS) need to be operationalized or translated into simple tools that can be overseen and managed by program and project teams to guide their practice (Schut et al. 2015). Without such operationalization, AIS approaches can easily be perceived as fuzzy with the risk of people abandoning their willingness to engage with systems approaches altogether.

One of the aims of Scaling Readiness is to support a complexity-aware decision-making process that assists R4D interventions in designing, implementing, and monitoring scaling strategies in a structured and evidence-based way. To this end, Scaling Readiness proposes an iterative cycle of five steps that builds on key principles and concepts that will be further discussed and illustrated in this chapter (Fig. 3.1).

This book chapter has four main objectives:

1. To briefly introduce the key principles and concepts of Scaling Readiness.
2. To explain how Scaling Readiness was used in the CGIAR Research Program on Roots, Tubers and Bananas (RTB) Scaling Fund.
3. To present a case study that illustrates how Scaling Readiness can support the development of better-informed scaling strategies for R4D interventions.
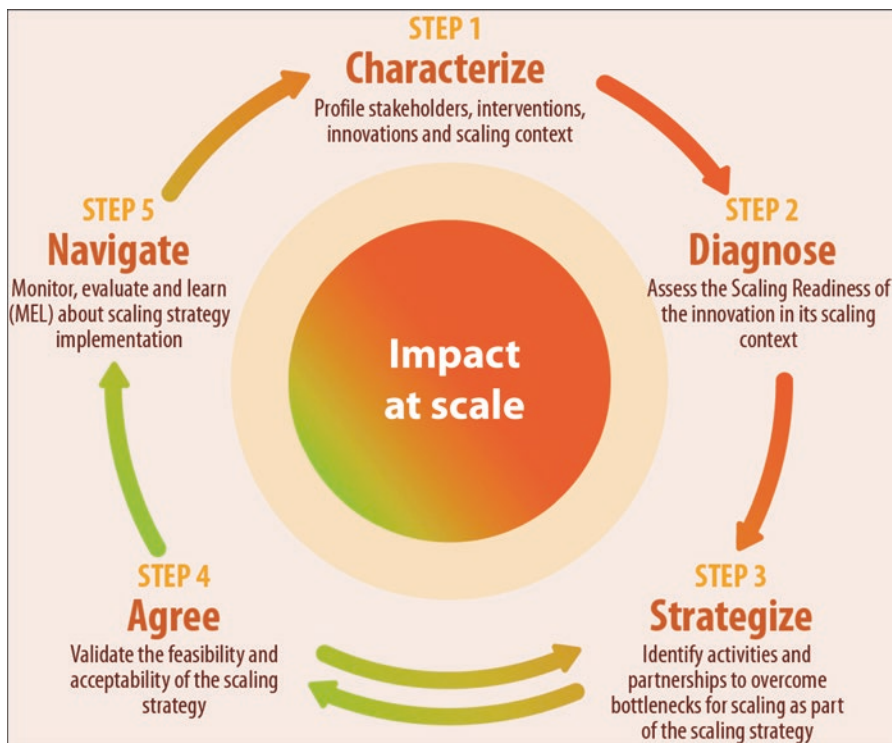4. To present lessons and recommendations for the further development and use of Scaling Readiness.

Fig. 3.1 Scaling Readiness proposes a stepwise approach to operationalize AIS thinking in support of the development, implementation, and monitoring of better-informed scaling strategies (Sartas et al. 2020b)

3.2 Scaling Readiness in the CGIAR Research Program on Roots, Tubers and Bananas Scaling Fund

In an attempt to close the gap between the *science* and the *practice* of scaling innovations, RTB developed an institutional innovation to support the scaling of RTB innovations: the *Scaling Fund*. Scaling Readiness was used in two distinct ways in the Scaling Fund: (1) to identify and select scaling-ready RTB innovations and (2) to nurture and support the design, implementation, and monitoring of strategies to scale those RTB innovations. Both will be explained in more detail in the below sections.

It is worthwhile mentioning that the RTB Scaling Fund provided an opportunity for Scaling Readiness not only to develop scaling strategies but also to test and improve the various tools, processes, and workstreams that Scaling Readiness offers.

3.2.1   Identifying and Selecting Scaling-Ready RTB Innovations

In 2017, a first call for Scaling Fund project proposals was announced and elicited 12 submissions that were assessed by an independent panel. Five of the proposals were selected to submit full proposals. The evaluation was based on the following assessment criteria:

1. Define and provide *evidence on the scaling readiness* of the selected RTB innovation (referred to as the *core innovation*).
2. Define *site-specific complementary innovations* or enabling conditions that are needed to scale the *core innovation*.
3. Scaling strategy in the proposal is *congruent with existing projects and public and private partners' initiatives*.

From the initial batch of five proposals, the three with the highest scores were awarded a total investment of approximately USD two million to further improve and implement their scaling strategies with their partners. In 2018 and 2019, five additional Scaling Fund projects were funded (Table 3.1).

Table 3.1 Overview of the eight Scaling Fund projects awarded and implemented between 2017 and 2021

RTB Scaling Fund batch	RTB Scaling Fund projects		
2018–2019	1. Single diseased stem removal (SDSR) for BXW banana disease in Burundi, eastern DR Congo, Rwanda, and Uganda	2. Triple S storage process for conserving sweetpotato roots to produce planting material in Ethiopia and Ghana	3. A technology for turning cassava peels into an ingredient of animal feed in Nigeria
2019–2020	1. Orange-fleshed sweetpotato (OFSP) puree for safe and nutritious food products and economic opportunities for women and youths in Kenya, Uganda, and Malawi	2. Approach for flash drying of cassava starch and flour at small scale in Nigeria, DR Congo, and Colombia	3. Rooted apical cuttings in Kenya
2020–2021	1. RTB crop variety validation and diffusion using farmer citizen science in Ghana and Rwanda (TRICOT)	2. A digital fertilizer recommendation service (AKILIMO) in Nigeria, Tanzania, and Rwanda	

3.2.2   RTB Scaling Strategy Design, Implementation, and Monitoring

After the initial selection of the Scaling Fund projects, a kick-off and capacity development workshop was organized for each batch of projects (Fig. 3.2). For 2–3 days, the Scaling Fund project teams were trained in the basics of Scaling Readiness and discussed how these would be applied and useful to their own Scaling Fund projects. At the end of the workshop, each of the project teams had a road map for the implementation of their Scaling Fund projects.

To ensure sufficient capacity within the projects to manage scaling processes and implement Scaling Readiness, a key requirement was to assign several people with designated functions, including scaling champions and Scaling Readiness monitors. The scaling champion was primarily responsible for the implementation of scaling strategies and stakeholder engagement plans. They were usually people with a good understanding of the innovation and the local partnership dynamics. Their role was to broker and network for key partners to work together and make scaling happen. The Scaling Readiness monitors were mainly responsible for applying the Scaling Readiness tools to collect and analyze data with the objective to influence decision-making and strategy development with the broader scaling project team. They were usually research assistants with good data collection and analysis skills.

Two different scaling consultants were recruited to backstop the scaling champions and Scaling Readiness monitors and to ensure cross-project learning. During

Fig. 3.2 Group photo of participants representing the three 2019–2020 Scaling Fund project teams during the kick-off workshop in Nairobi, Kenya

the two years of implementation, the scaling champions, Scaling Readiness monitors, and scaling consultant worked closely together with the Scaling Fund project teams.

One of the 2019–2020 Scaling Fund projects (a scaling approach for flash drying of cassava starch and flour at small scale in Nigeria, DR Congo, and Colombia) is used as a case study in this book chapter to explain how Scaling Readiness was used. The cassava flash drying project was selected because of its systematic use and documentation of the Scaling Readiness approach.

3.2.3   Introduction to the Scaling Fund Cassava Flash Dryer Case Study

Cassava is a starchy root crop that is a major staple food for people in developing countries. It is grown in tropical regions of the world because of its ability to withstand difficult growing conditions. Cassava in sub-Saharan Africa is generally a subsistence crop, but there is increased commercial interest here in processing cassava flour and for starch production. Rapid perishability of roots requiring agile and efficient processing is one of the greatest challenges facing smallholder cassava farmers and small-scale cassava processors. The most common practice is sun-drying cassava roots to make flour, which is challenging during the extended rainy seasons in the tropics and affects the overall quality of the starch. As a result, farmers and small-scale processors face difficulties to offer their produce to industries that need regular, all-year-round supply and consistent quality for flour and starch production (IITA 2016).

Flash drying, compared to sun drying, enables substantial gains in product quality and productivity by reducing the drying time from between 10 and 48 hours to a few seconds and providing constant drying conditions. Flash dryers are used mostly by large-scale processors (production capacity of >50 tons of starch/day) in countries such as Brazil and Thailand, which have highly developed commercial starch production. Small-scale flash dryers (production capacity of between 1–3 tons of flour/day) are not widely used due to a combination of factors including high energy consumption and production costs. Since 2013, more reliable methods to design energy-efficient flash dryers, based on numerical modelling, have been developed and successfully tested in small-scale pilot flash dryers (Fig. 3.3) that have proven to achieve the same energy efficiency as large-scale industrial flash dryers.

The Scaling Fund Cassava Flash Drying project focusses on three countries where the scaling of small-scale flash dryers has potential: Colombia, DR Congo, and Nigeria. In Nigeria, between 2006 and 2016, prior to the Scaling Fund project, 157 cassava processors had invested in first-generation small-scale flash dryers to produce cassava flour. However, 50% of these are not in use anymore because of the low energy efficiency and subsequent high costs of operation. In the DR Congo, the long rainy season (1300–1900 mm/year) led to strong demands for cost-effective drying solutions such as flash drying. In Colombia, labor-intensive sun drying is costly, motivating cassava processors to seek other drying solutions to increase their

Fig. 3.3 Example of a small-scale cassava flash drying system in Nigeria

production capacity and reduce costs. In each of these countries, partners who were willing to co-invest were identified and brought on board. An initial scaling strategy was proposed in 2019 to train scaling partners (equipment manufacturers and cassava processors) on theoretical and practical aspects of building and operating energy-efficient small-scale flash dryers. In addition, the Scaling Fund project would provide technical support to enable scaling partners to upgrade their existing flash dryers or to invest in new ones. During the project, the Scaling Readiness approach was used to identify bottlenecks and adjust the scaling strategy.

3.3 Principles, Concepts, and Case Study Application of Scaling Readiness

This section introduces the main Scaling Readiness principles and concepts and describes how these were applied in the cassava flash dryer case study following the five Scaling Readiness steps (Fig. 3.1).

3.3.1 Scaling Readiness Step 1: Characterize

During step 1, the project team characterizes the innovation, innovation package, and scaling contexts to explore interdependencies related to the scaling ambitions and aspired impacts.

3.3.1.1   Scaling Readiness Step 1: Principles and Concepts

Scaling Innovation Requires Context-Specific Approaches

A key starting point for Scaling Readiness is that scaling is contextual. Whether something goes to scale and supports the achievement of desired outcomes or impacts depends, for example, on the specific institutional setting (including cultural values, market arrangements, legal frameworks, and policy conditions), on agroecological conditions, and on the interactions that take place within and between networks of interdependent actors and stakeholders (Klerkx et al. 2010; Schut et al. 2015). This implies that an innovation may be scalable in one context but not in another and that scaling strategies successful in one situation may not be effective elsewhere or at another point in time (Baur et al. 2003; Sartas et al. 2019). Similarly, the outcomes of scaling may vary across contexts.

Innovations Never Scale in Isolation

There has been a tendency in both theory and practice to focus on the scaling of a particular – often technological – innovation (Rogers 2003). However, research has shown that the scaling of one particular innovation (e.g., a hybrid seed variety) depends on the simultaneous uptake or enhancement of other practices and services (e.g., seed multiplication, input provision, reorganization of labor, pro-poor credit models, etc.) and/or the downscaling of preexisting practices (e.g., use of open pollinated seed). All of these require attention for successful scaling.

In Scaling Readiness, we consider all innovations or changes that need to take place, including products, technologies, services, and institutional arrangements, and distinguish between "core" and "complementary" innovations. The *core innovation* refers to the initial innovation that an R4D intervention or project aims to develop or scale in order to achieve an assumed societal benefit, for example, the cassava flash dryer. *Complementary innovations* are additional advances or changes in technology, capacity, or policy on which the scaling of the core innovation depends. Together these are labelled the "innovation package."[1] In view of the contextual nature of scaling, the composition of a viable and meaningful innovation package is likely to differ across contexts. That is, the package of core and complementary innovations that is advocated needs to be tailored to different contexts, different target beneficiaries (e.g., specific gender or age groups), and may also need to change over time in view of changing conditions.

On target beneficiaries specifically, there is evidence that different groups in society may face diverse challenges and opportunities in having awareness of, having access to, being able to use, and/or benefitting from innovations. If, for example, market information is provided through a mobile phone-based SMS

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[1] See also Bundling innovations to transform agri-food systems. Nature Sustainability 3(12): 973

service, this may benefit men who typically have more control over the household's mobile phone than women. Additional innovations that provide the same market information through a different channel (e.g., printed information provided at a community health center where women regularly visit) may be considered while trying to address some of the underlying inequalities with regard to control over communication assets. This shows that different combinations of core and complementary innovations as part of an innovation package need to be considered for achieving a specific objective or outcome. By being explicit about target beneficiaries during step 1, different types of innovation packages can be considered and designed for different groups of beneficiaries.

3.3.1.2 Scaling Readiness Step 1 in the Cassava Flash Dryer Case Study

During step 1 of Scaling Readiness, the project team characterized the innovation and its context and formulated context-specific innovation package(s) for the three countries. In the flash dryer case study, all core and complementary innovations were defined by the project team and its partners with backstopping from the scaling consultant. A total of 15 core and complementary innovations (Table 3.2) were characterized. The innovations were classified under different innovation types including technologies (i.e., the subcomponent of the machinery), products, services, and institutional arrangements. Since the contexts are different, complementary innovations necessary to scale the flash dryer also differed among the countries.

3.3.2 Scaling Readiness Step 2: Diagnose

During step 2, the project team assesses the current readiness and use of the various core and complementary innovations in the innovation package with the aim of identifying the main bottlenecks toward scaling.

3.3.2.1 Scaling Readiness Step 2 Principles and Concepts

The Scaling Readiness of an Innovation Is a Function of Innovation Readiness and Innovation Use

The notion of "innovation readiness" refers to the demonstrated capacity of an innovation to fulfill its promise or contribute to specific development outcomes. The level of innovation readiness increases as innovations progress from an untested idea to something that has been validated to work in an artificial setting (e.g., a laboratory or controlled project environment) all the way to settings where the innovation has fully matured and has been proven to work under uncontrolled

Table 3.2 Description of the flash dryer core and complementary innovations in the country-specific innovation packages

Core/ complementary innovation	Innovation type	Description	Geographical relevance		
			Nigeria	DR Congo	Colombia
Core innovation	Technology	The **Efficient Flash Dryer** is a pneumatic-conveying dryer that reduces processing cost due to innovative design.	x	x	x
Core innovation sub-component	Technology	Innovation in **the starch/ flour feed system** to the dryer that improves the homogeneity (particle size) of the supply	x	x	x
Core innovation sub-component	Technology	Technological proposal of **mechanical pre-treatment of the raw material** to reach +/- 35% humidity prior to flash drying. Options considered are press and/or centrifuge to remove water	x	x	x
Core innovation sub-component	Technology	**Hot air generator designs** adapted to the requirements and particular conditions of each country to optimize energy consumption and production costs. Depends on type of fuel available (e.g., diesel, gas, agricultural residues/biomass, etc.) and type of burner technology and heat exchanger technology available	x	x	x
Core innovation sub-component	Technology	**New fans/blowers** to achieve sufficient air velocity and flow rate, which improves production capacity	x	x	
Core innovation sub-component	Technology	Adaptation of **drying technology** to the production of sour cassava starch by testing the expansion quality of flash dried sour starch compared to sun-dried			x
Complementary innovation	Product	Preparing a **business plan template** for estimation of costs of investment and operations; estimation of revenues generated; business plans and testing them with manufacturers and processors	x	x	x
Complementary innovation	Product	A spreadsheet **template for assessing availability of raw material and energy** at acceptable cost in the target locations for a cassava starch/flour factory	x	x	x
Complementary innovation	Service	Stimulation of the cassava flour market and **promotion** through social networks; creation of new linkages between actors in the cassava flour value chain and exploration of new domestic and international markets	x		x
Complementary innovation	Service	Information from banks about the conditions and **support** to provide to access investments **loans**	x		
Complementary innovation	Service	**Capacity building** on installing and operating flash dryers	x	x	x
Complementary innovation	Service	Technical forum through facilitated **WhatsApp group** (English) and **technical support** through visits to construction sites	x	x	x
Complementary innovation	Institutional arrangement	A big physical gathering, **forum**, to bring together and promote multi-stakeholder dialogue between entrepreneurs, processors, eqpt manufacturers, funders, government agencies, etc.	x	x	x
Complementary innovation	Institutional arrangement	Assess the feasibility of establishing **cooperatives** of cassava producers (possible support by central bank loans) to ensure sufficient supply of cassava roots to the proposed starch or flour factories	x	x	x
Complementary innovation	Institutional arrangement	**Contracts** between processors, equipment manufacturers, and project teams in order to define the responsibilities, commitments (financial and otherwise), and expected benefits of all parties	x	x	x

Technologies are presented in green, products in blue, services in yellow, and institutional arrangements in orange

conditions (Table 3.3). In contrast to the notion of "technology readiness" that is used by NASA and EU, we use the term "innovation readiness" to signal that the framework can also be applied to measure the maturity of non-technological innovations.

Table 3.3 Innovation readiness and innovation use levels, short names, and basic descriptions of each term (Sartas et al. 2020a)

	Innovation readiness		Innovation use	
Level	Short name	Basic description	Short name	Basic description
0	Idea	Genesis of the innovation. Formulating an idea that an innovation can meet specific goal	None	Innovation is not used for achieving the objective of the intervention in the specific spatial-temporal context where the innovation is to contribute to achieving impact
1	Hypothesis	Conceptual validation of the idea that an innovation can meet specific goals and development of a hypothesis about the initial idea	Intervention team	Innovation is only used by the intervention team who is developing the R4D intervention
2	Basic model (unproven)	Researching the hypothesis that the innovation can meet specific goals using existing basic science evidence	Effective partners (rare)	Innovation has some use by effective partners who are involved in the R4D intervention
3	Basic model (proven)	Validation of principles that the innovation can meet specific goals using existing basic science evidence	Effective partners (common)	Innovation is commonly used by effective partners who are involved in the R4D intervention
4	Application model (unproven)	Researching the capacity of the innovation to meet specific goals using existing applied science evidence	Innovation network (rare)	Innovation has some use by stakeholders who are not directly involved in the R4D intervention but are connected to the effective partners
5	Application model (proven)	Validation of the capacity of the innovation to meet specific goals using existing applied science evidence	Innovation network (common)	Innovation is commonly used by stakeholders who are not directly involved in the R4D intervention but are connected to the effective partners
6	Application (unproven)	Testing of the capacity of the innovation to meet specific goals within a controlled environment that reflects the specific spatial-temporal context in which the innovation is to contribute to achieving impact	Innovation system (rare)	Innovation has some use by stakeholders who work on developing similar, complementary, or competing innovations but who are not directly connected to the effective partners

(continued)

Table 3.3 (continued)

	Innovation readiness		Innovation use	
Level	Short name	Basic description	Short name	Basic description
7	Application (proven)	Validation of the capacity of the innovation to meet specific goals within a controlled environment that reflects the specific spatial-temporal context in which the innovation is to contribute to achieving impact	Innovation system (common)	Innovation is commonly used by stakeholders who are developing similar, complementary, or competing innovations but who are not directly connected to the effective partners
8	Incubation	Testing the capacity of the innovation to meet specific goals or impact in natural/real/uncontrolled conditions in the specific spatial-temporal context in which the innovation is to contribute to achieving impact with support from an R4D	Livelihood system (rare)	Innovation has some use by stakeholders who are not in any way involved in or linked to the development of the R4D innovation
9	Ready	Validation of the capacity of the innovation to meet specific goals or impact in natural/real/uncontrolled conditions in the specific spatial-temporal context in which the innovation is to contribute to achieving impact without support from an R4D	Livelihood system (common)	Innovation is commonly used by stakeholders who are not in any way involved in or linked to the development of the R4D innovation

However, the maturity of an innovation along the innovation readiness scale is not the only factor that is important for understanding and assessing the scalability of an innovation or innovation package in a specific context. There are many examples of innovations with a high level of readiness that were never used at scale. Similarly, there are also examples of innovations that go to scale even if their performance is limited, contested, or poorly documented. Scaling Readiness, therefore, assumes that scalability also depends on the networks in which innovations are embedded and through which their use is supported and advocated (Geels and Schot 2007; Leeuwis and Aarts 2011; Hermans et al. 2017). For example, it makes a difference whether an innovation is only being used by directly incentivized R4D project partners or whether there are partners or beneficiaries that use or promote the innovation independently from the R4D intervention. To capture the degree to which an innovation has penetrated networks, we have introduced the notion of "innovation use" (Table 3.3). The concept also measures the relative magnitude of use (e.g., rare vs. common) to indicate both the scalability potential and actual innovation use at scale. Innovation use is measured using a network analysis approach (Sartas et al. 2018; Sartas et al. 2020a). Scaling readiness, then, must be seen as the function of innovation readiness and innovation use.

Fig. 3.4 Stylized example of an innovation package (with 8 innovations) that have been assessed for their innovation readiness (y-axis) and innovation use (x-axis) specific to space, time, and goals (Sartas et al. 2020a)

In step 2 of Scaling Readiness, these three concepts are used for diagnostic purposes. With the help of survey techniques, each innovation in a package is assessed for its innovation readiness and innovation use, and evidence of the proclaimed assessment is provided. The scaling readiness of a particular core or complementary innovation results can be found by multiplying the two scores. If the innovation readiness of a particular innovation in the package is at level 3 and innovation use at level 2, the scaling readiness for that innovation is 6 (Fig. 3.4).

3.3.2.2 Scaling Readiness Step 2 in the Cassava Flash Dryer Case Study

Based on the innovation packages defined for the flash dryer scaling work in Colombia, DR Congo, and Nigeria, the project team assessed the innovation readiness and innovation use. The first step to determine the innovation readiness and innovation use level was to collect background information via a short desktop study. The Scaling Readiness monitors gathered information about the available evidence on the readiness and use of the innovation package core and complementary innovations from academic and technical databases and repositories. To complement the desktop study, the project team also collected new data. For the innovations categorized as *core innovation subcomponents*, small-scale processors of cassava flour and starch and flash dryer manufacturers from Colombia, DR Congo, and Nigeria were visited at each location to collect technical information
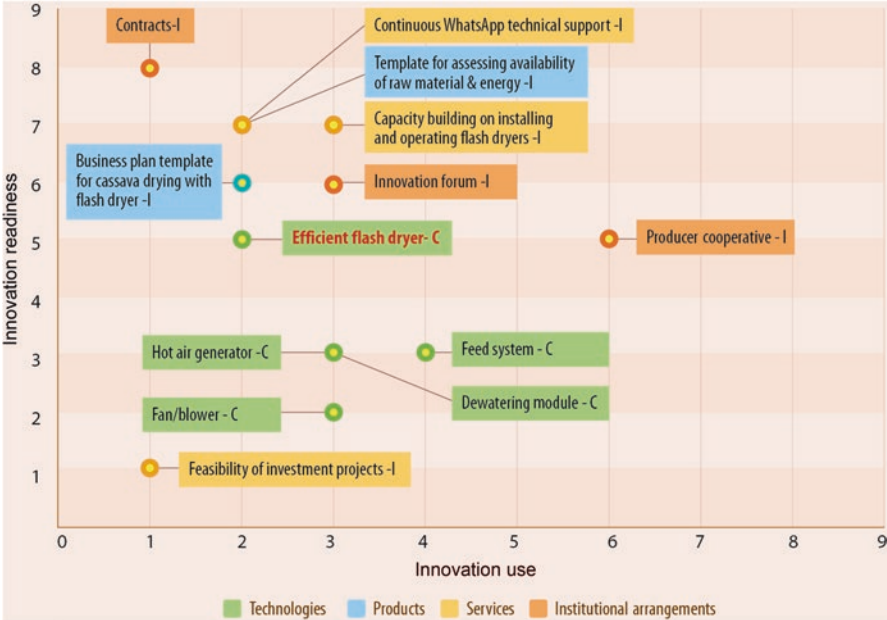
Fig. 3.5 Assessment of the innovation readiness and innovation use of the cassava flash dryer innovation package in Nigeria. (The boxes in Figs. 3.5, 3.6, and 3.7 that include "C" are the core innovation subcomponents of the flash dryer, and "I" refers to complementary innovations. Technologies are presented in green, products in blue, services in yellow, and institutional arrangements in orange.)

used in the analysis. For innovations categorized as *services* and *institutional arrangements* (Table 3.2), information was collected through surveys with different value chain actors, such as bankers, cassava producers, processors, and representatives of government organizations, among others. These surveys were administered during stakeholder meetings and forums in each location.

The information collected via the desktop review, field measurements, and survey results were processed by the Scaling Readiness monitor to determine the innovation readiness and innovation use level for each of the innovations in the innovation package for the three country contexts. A Microsoft Excel template was used to plot the Scaling Readiness graph. The template enabled selection of innovation readiness and innovation use levels from a drop-down list and automatically generated the graph (see Figs. 3.5, 3.6, and 3.7). To validate the results, the Scaling Readiness monitor presented the template to the project team and collaborators and to other key project partners who made their contributions.

The innovation readiness levels ranged between 1 and 8, while the use scores ranged from 1 to 7. These indicated that innovation packages included some new ideas (e.g., organizing an innovation forum in Colombia). Some of the subcomponents of the flash dryer were at the conceptual model stage and not yet validated by the existing applied literature (e.g., fan/blower in Nigeria and DR Congo), while other
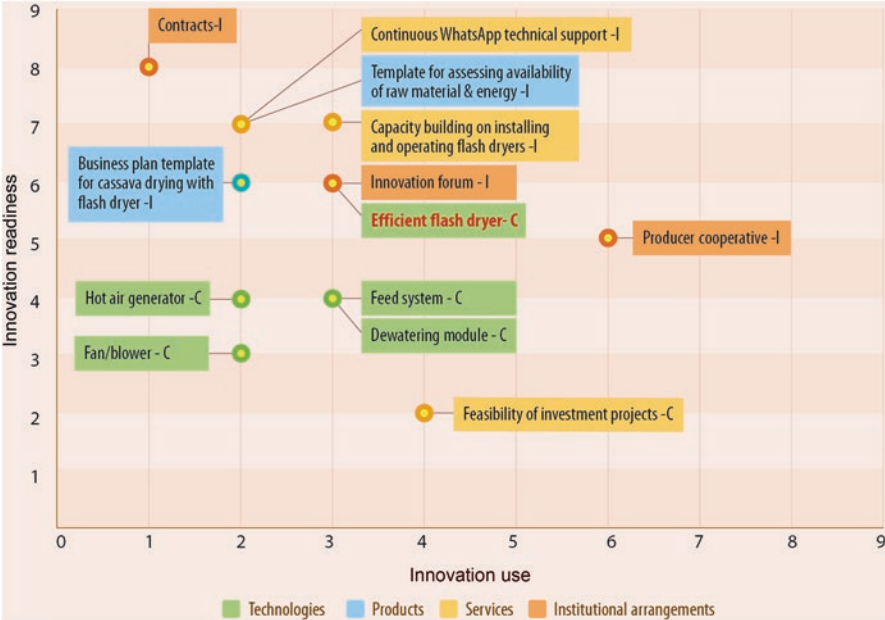
Fig. 3.6 Assessment of the innovation readiness and innovation use of the cassava flash dryer innovation package in DR Congo
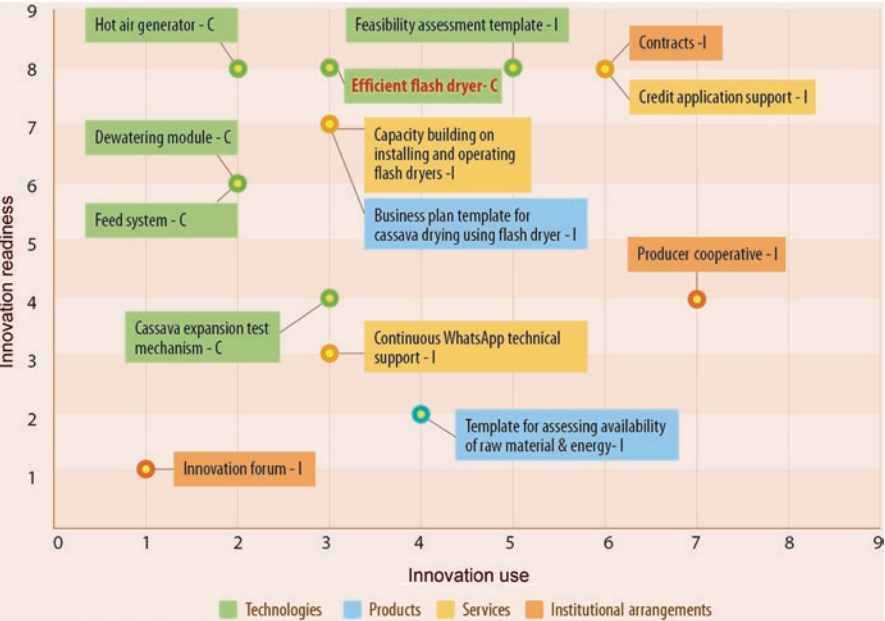

Fig. 3.7 Assessment of the innovation readiness and innovation use of the cassava flash dryer innovation package in Colombia

innovations (e.g., continuous WhatsApp technical support mechanism) were shown to work without a support from R4D interventions in real conditions. Also, the readiness and use levels of some of the components varied among different locations. For example, contracts between the cassava producers and processors were not used in DR Congo and Nigeria beyond those contracts of the project partners, while contracts are commonly used in Colombia.

The diagnosis of the innovation packages indicated that "strengthening the *feasibility of investment projects* through market promotion campaigns for small-scale cassava flour" was the key bottleneck in Nigeria. There was no campaign design that could guide the flash dryer marketing (innovation readiness level 1), and the idea of having flash dryer market promotion campaigns was still under development by the project team (innovation use level 1). In addition, some technical subcomponents of the flash dryer (i.e., hot air generator, dewatering module, and fan/blowers) were assessed at the lower readiness and use, thus needing a strategy for improvement.

In Colombia, the lack of an "innovation forum" was identified as the key bottleneck (Fig. 3.7). "Continuous WhatsApp technical support" for cassava flash dryer installation and use and a "cassava expansion testing" mechanism for the flash dryer were prioritized as the other bottlenecks.

To identify the key partners to overcome the bottlenecks, the flash dryer team used social network analysis. A survey was administered to potential partners, and results were used to characterize stakeholders and partners. Due to the limitations caused by COVID-19, only a few identified partners could be feasibly reached, and those reached did not occupy the most strategic positions in the network. Findings were captured in the stakeholder engagement reports written for DR Congo and Nigeria (Taborda et al. 2020a, 2020b).

3.3.3 Scaling Readiness Step 3: Strategize

During step 3, the project team considers different options and strategies that may be used to address the main bottlenecks to scaling for each innovation package.

3.3.3.1 Scaling Readiness Step 3 Principles and Concepts

Bottlenecks for Scaling Can Be Identified by Assessing Innovation Readiness and Innovation Use

When the core and complementary innovations have been assessed for their level of innovation readiness and innovation use, it becomes pertinent to think about strategies to enhance the readiness of the package as a whole. Scaling Readiness directs most attention to the innovations in the package with the lowest levels of readiness and use, labelled "bottleneck innovations," as they are most likely to limit the scaling of the innovation package. Unless bottlenecks have been addressed, the
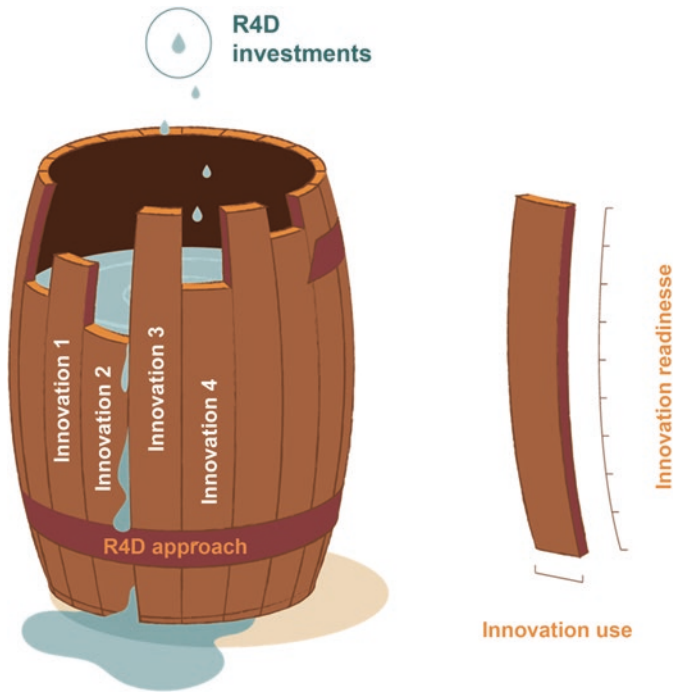
Fig. 3.8 Scaling Readiness barrel to illustrate how innovation(s) with the lowest readiness limits an innovation package's capacity to achieve impact at scale. (Adapted from "von Liebig's barrel," after Whitson and Walster 1912; published in Sartas et al. 2020a, 2020b)

value added to the effort in core or complementary innovations that already have a relatively high innovation readiness and innovation use is low. This point is illustrated in Fig. 3.8, where one can observe that R4D investments (symbolized as water drops) are wasted as they leak away from the lowest stave in the barrel, which symbolizes the bottleneck in the innovation package.

Bottleneck Innovations Can Be Overcome Through Different Strategic Options

Scaling Readiness distinguishes strategic options (i.e., innovation management options) that may be used that address a bottleneck. The choice of an appropriate strategy may be informed by available time, financial and human resources, and organizational mandates and capacities, considering what is feasible and resource efficient (derived from Sartas et al. 2020a):

1. *Substitute:* Can the bottleneck be replaced by another innovation with higher readiness and/or use in the given context?

2. *Outsource*: Are there any organizations or external experts that can more efficiently improve the Scaling Readiness of the bottleneck?
3. *Develop*: Can the intervention team improve the readiness and/or the use by investing available intervention capacities and resources?
4. *Relocate*: Can the intervention objectives be realized more effectively if the intervention is implemented in another location where innovations have higher readiness and use levels?
5. *Reorient*: Can the objective or outcome of the intervention be reconsidered if addressing the bottleneck is not possible and relocation is not an option?
6. *Postpone*: Can scaling the innovation package be achieved at a later point in time?
7. *Stop*: If none of the above strategic options are feasible, should the team consider stopping the intervention?

The strategic options are ranked according to their resource intensity, starting with the least demanding option. The options effectively imply reconsideration of the innovation package and/or the objectives and context of scaling. While we realize that existing project frameworks, budget allocations, and partnership configurations may pose limits to choosing the most sensible and efficient option, Scaling Readiness assumes that considering all options enhances discussion and critical reflection in project teams and thus contributes to the prioritization of relevant and feasible strategies to overcome bottlenecks for scaling. Clearly, the options chosen have further practical implications in terms of who are relevant partners to work with.

3.3.3.2   Scaling Readiness Step 3 in the Cassava Flash Dryer Case Study

From June 2019 onward, the flash dryer project team, scaling champions, and Scaling Readiness monitors explored strategic options for each country. Each bottleneck was discussed, and the most viable options were explored in consultation with key stakeholders and experts. Further information on the strategies is provided in Sect. 3.3.4.2.

3.3.4   Scaling Readiness Step 4: Agree

During step 4, the proposed scaling strategies are shared and discussed with relevant stakeholders to work toward effective collaboration with partners relevant to scaling.

3.3.4.1 Scaling Readiness Step 4 Principles and Concepts

Implementing Scaling Strategies Requires Multi-stakeholder Agreement
and Coalition Building

The scaling of an innovation package inherently requires the involvement and coop-
eration of the various stakeholders. Depending on the package and bottlenecks,
these may include policy makers, value chain parties, farmer organizations,
community leaders, and/or service (e.g., extension and credit) providers. While
AR4D projects depend on the collaboration of such partners to realize their scaling
ambition, these parties may not necessarily agree with the proposed scaling strategy,
nor may they be ready to take effective action (Sahay and Walsham 2006; Wigboldus
et al. 2016). Thus, it is important that initiatives are taken to align interdependent
actors and work toward agreement and accommodation on, for example, objectives,
strategies, task division, timelines, and investment of resources to enable scaling.

In essence, the process of aligning stakeholders amounts to building an effective
coalition that supports change in a particular direction, even if the rationales and
interests of stakeholders may only partially overlap (Biggs and Smith 1998; Aarts
and Leeuwis 2010). Reaching the necessary degree of accommodation and
consensus is far from automatic and often requires active facilitation of learning and
negotiation (Leeuwis and Aarts 2011).

3.3.4.2 Scaling Readiness Step 4 in the Flash Dryer Case Study

From June 2019 onward, the flash dryer project team began engaging partners and
broader stakeholders in multiple countries to discuss the proposed strategies to
improve the scaling readiness of the flash dryer innovation package. In August
2019, combined with a training workshop on small-scale flash drying, the cassava
flour processors and equipment manufacturers partners were presented the strategies,
and their feedback was collected.

Based on the consultations with partners and key experts and feedback from the
workshop, a final strategy for scaling the flash dryer was formulated for the three
countries (Table 3.4). To enhance the commitment of the partners to the new strategy,
partners were requested to provide their consent and support in writing clearly
specifying their intention to participate in the implementation of the scaling action
plans. This took the form of an umbrella *participation agreement* explaining the
roles, responsibilities, and commitments of the partners (processors, equipment
manufacturers) and of the project team to accomplish the goals of the project.

Table 3.4 Scaling Readiness strategic options selected to overcome the bottlenecks for scaling the cassava flash dryer innovation in the different project countries

Bottlenecks (see Figs. 3.5, 3.6, and 3.7)	Bottleneck description	Location	Strategic option	Strategy description
Strengthening the feasibility of investment projects through market promotion campaigns for small-scale cassava flour	Initially, the campaign was conceived to address the lack of markets for small-scale flour producers. However, *the agree step* showed that the dominant majority of the processors did not think increasing the markets is viable in the short term due to the huge efficiency gap and lack of the implementation of the existing local production incentives	Nigeria	Reorient	Since yam prices are higher and yam dryer has higher profitability, the team decided to explore options to use flash dryer for yam
			Postpone	To capitalize a possible favorable change in cassava markets, a demonstration flash dryer was built for promotion and training at the R&D institution FIIRO (although an impact was not anticipated until the end of the project)
Fan/blower, hot air generator, and dewatering subcomponent (only Nigeria)	The capacity of fans to achieve adequate air velocity was too low, resulting in low production capacity. Since the flash dryer team had advanced engineering capabilities, the team chose to optimize the fan/blower designs, share those designs with the manufacturers, and help processors to install them	DR Congo/ Nigeria	Develop	The team has worked on developing the fan and calibrating this tool for efficient drying. Improved fans/blowers were developed and installed (see Figs. 3.5 and 3.6)
Innovation forum	The flash dryer team initially strategized that an innovation forum could increase the awareness of the cassava processors and match them with manufacturers of flash dryers, creating business opportunities	Colombia	Develop and outsource	The team started preparations for the forum and engaged with several organizations to co-organize with. Several activities were planned for outsourcing with other organizations

(continued)

Table 3.4 (continued)

Bottlenecks (see Figs. 3.5, 3.6, and 3.7)	Bottleneck description	Location	Strategic option	Strategy description
Continuous WhatsApp technical support	At the strategizing step, based on the cassava project experience in Africa, the flash dryer team identified that a WhatsApp group could be an instrument for building capacity with the manufacturers and processors	Colombia/ DR Congo/ Nigeria	Develop	The team has opened the WhatsApp group and invited the manufacturers and processors from Africa and Latin America who attended the august workshop in Cali. The information traffic in this network and number of members increased continuously
Cassava expansion mechanism	In Colombia, cassava starch is used for special breads, which requires the expansion. The team has strategized that it can further develop the flash dryer	Colombia	Develop	The team conducted an experiment to measure the effect of various expansion options

3.3.5 Scaling Readiness Step 5: Navigate

During step 5, the project teams monitor the unfolding dynamics in relation to the implementation of agreed-upon scaling strategies and scaling action plans and signal whether major changes in the innovation package configuration or scaling context require a new cycle of Scaling Readiness assessment.

3.3.5.1 Scaling Readiness Step 5 Principles and Concepts

Scaling Projects Need Capacity to Adjust to Emergent Dynamics

When implementing scaling strategies, partners and project teams are likely to meet with unforeseen developments and unintended effects (Hall and Clark 2010; Paina and Peters 2012). This is because scaling contexts are ever-changing and, therefore, can never be fully anticipated (Schot and Geels 2008). It is quite conceivable, for example, that scaling partners meet with new constraints and challenges in their efforts to enhance the Scaling Readiness of a package, or that successful scaling appears to have unwanted side effects for the environment or for specific segments in farming communities. Thus, AR4D interventions require mechanisms to capture and navigate such emergent dynamics. Thus, project teams need to continue to

invest in learning and critical reflection when scaling strategies and action plans are implemented.

Relatedly, Scaling Readiness distinguishes between short- and long-term learning cycles and feedback loops (Sartas et al. 2020b). In short-term learning and feedback loops, the focus is on monitoring how the agreed-upon action plans for addressing the bottlenecks are being implemented and on whether plans must be adapted. The long-term learning and feedback loop actually involves a new round of going through the Scaling Readiness cycle, starting with reiterating the Characterize Step 1 and Diagnose Step 2 (See Fig. 3.1). Here, the emphasis is on assessing whether the scaling context has changed and on whether the implementation of scaling strategies has yielded the desired effects. Insights derived from such assessments may result in a reconfiguration of the innovation package, the identification of new bottleneck innovations, and subsequent adaptation of agreed-upon scaling strategies.

3.3.5.2 Scaling Readiness Step 5 in the Cassava Flash Dryer Case Study

The flash dryer team has implemented the agreed-upon strategies presented in Table 3.4 and closely monitored the activities and whether they resulted in the desired improvements in the project. However, travel restrictions due to the COVID-19 pandemic and related closure of businesses necessitated changes in the strategies.

Short-Term Learning and Feedback Loops

In Colombia, the innovation forum was initially postponed (and later cancelled altogether) when the project team realized that the COVID-19 travel restrictions would last much longer than expected. Furthermore, the partners that would co-invest in the flash dryer suspended their commitments to the project and their investment plans. In addition, the development efforts of the flash dryer by the team for the cassava expansion mechanism did not result in desired improvements. As a result, the flash dryer team has decided to stop activities in Colombia and revisited the Scaling Readiness strategic options, adopting a dual strategy:

1. *Relocate and outsource*: Initial consultations with processors in the Dominican Republic showed that there is large interest for the flash dryer; thus, the team decided to relocate there. Since the Dominican Republic was not one of the initial project countries and because the organizational partners of RTB do not have implementation capabilities, the team also decided to outsource the work there to a company called Angavil. The project provided technical support to Angavil to develop its investment plans in flash drying technology for production of cassava flour in the Dominican Republic.

2. *Reorient the flash dryer toward production of high-grade cassava starch* for bioplastics and support an initiative led by the Universidad del Cauca to develop a start-up company in Colombia, funded by Colciencias, the national agency for scientific development. The flash dryer project team decided to provide technical support to this initiative.

In Nigeria, the main bottlenecks were market options for cassava flash drying and inefficient fans/blowers that increased the cost of drying (Fig. 3.5). The customers of cassava flour (e.g., millers, brewers) required much higher volumes than could be supplied by small-scale producers. The buyers typically demand 30 or 60 tons per order, whereas some of the small-scale cassava flour factories can produce up to 1–2 tons per day. This situation led to underutilization of the flash drying capacity since some of the flour producers were too small to be economically viable suppliers for the large-scale buyers: Only 32 flash dryer businesses (out of 64 known flash dryers) were viable users for the cassava flash drying. The fans/blowers of the drying system presented another bottleneck in Nigeria. The team has developed the fans/blowers of the drying system by designing improvements and testing them in the flash drying producers' workshops (Table 3.4).

In the DR Congo, like Nigeria, the main bottleneck was the fans/blowers (Fig. 3.6).

The capacity of fans to achieve adequate air velocity was too low, resulting in low production capacity. Equipment manufacturers acknowledged that they did not have enough experience to build larger fans (due to balancing issues with the rotor) and that they did not know the methods to determine the efficiency of the fan (e.g., air velocity measurements). To address this need, the complementary innovation of flash dryer fans/blowers was added to the innovation package. The team has worked on developing the fan and is calibrating it for efficient drying (Table 3.4).

In both Nigeria and DR Congo, the *heat exchanger* was developed with the goal of driving specific modifications to existing (diesel) heat exchanger designs as well as promoting the manufacture of a new, more efficient heat exchanger design. Out of eight initial private sector scaling partners, three had adopted this innovation by the end of 2019 and increased their processing capacity by 23–50% and profitability by 8–10% – which corresponds to an extra USD 10,000 per year per processor. Cassava producers also benefit from a higher processing capacity, which increases the demand for cassava roots and, hence, economic opportunities for farmers in the regions around cassava factories. Since the most commonly used fuel in Nigeria and DR Congo is diesel, the partners were recommended to change their heating systems to liquid propane gas (LPG), as long as the price of LPG stays competitive in the region. This is a more cost-effective solution (because there is no need to manufacture a heat exchanger) and approximately 10% more efficient with respect to the use of diesel. In 2020, two partners in DR Congo invested in this innovation.

In the Dominican Republic, a scaling action plan was agreed to in early 2020 between the cassava processors, equipment manufacturers and R4D team. The plan

was then revised several times through short-term feedback loops. The main feedback was related to the definition of responsibilities for the investment risk, as the cassava processor wanted a guaranteed return on investment, while the equipment manufacturer or the R4D team could not take responsibility for this guarantee due to the novelty of the innovation. Each of the partners reviewed their expectations until the scaling action plan was revised and agreed upon.

Long-Term Learning and Feedback Loops

The short-term learning and changes in the strategies were complemented by an annual assessment of activities. The teams initiated a second Scaling Readiness characterization Step 1, but due to the COVID-19 pandemic, the collection of necessary qualitative information was difficult and this step was suspended.

More generally speaking, in all countries, the COVID-19 pandemic affected most of the programmed activities. For example, two project partners in Latin America (from Colombia and the Dominican Republic) postponed their planned investment in the flash dryer due to the economic impact of the pandemic and a 17% increase in the price of the flash dryer due to the depreciation of the local currency.

The pandemic also caused new challenges and/or bottlenecks to emerge. For example, providing remote technical support for dryer manufacturing, installation, and testing was slower and more complicated than doing it on-site. Some instructions and recommendations provided by video conference were misinterpreted, leading to a need to repeat the work and consequent extra costs. Additionally, in some places in Nigeria and DR Congo, Internet service and electricity supply are patchy, which hindered effective communication with project partners. One strategy to provide efficient remote technical support during the pandemic was the development of protocols and video tutorials for the project partners (e.g., step-by-step assessment methodologies for drying efficiency).

In Nigeria, the implementation of scaling action plans was slower than expected as most project partners delayed their decisions to invest in the flash dryer innovations. Consultation with the different actors in the high-quality cassava flour value chain revealed an emerging bottleneck that had not been identified during the initial Scaling Readiness characterization and diagnosis steps, namely, the rising cost of cassava roots in 2020 that reduced the profit margin of processing. A detailed economic analysis revealed the limited use of high-yielding varieties and good agronomic practices as two of the underlying causes for the limitations.

Although the flash dryer Scaling Fund project did not have the time nor resources to contribute directly to the improvement of cassava production yields scenario, exploring *synergies with other projects* (see Fig. 3.5) became an immediate priority, and a cooperation with the African Development Bank-funded Technologies for African Agricultural Transformation (TAAT) program was established. This program has pursued an objective to provide technical assistance for efficient cassava root production in several African countries, including Nigeria. Overcoming

this bottleneck will be key to reducing the cost of cassava roots and related bottle-necks on investment in processing of high-quality cassava flour.

Toward the end of the project, due to the persistence of the COVID-19-related limitations, the team decided to create a virtual platform to scale the flash dryer. Having realized that returning to previous offline work is unlikely, digital solutions were considered one of the best options for advancing the scaling work.

3.4 Reflection on the Use of Scaling Readiness in the RTB Scaling Fund

3.4.1 Reflections on the Use of Scaling Readiness by the Flash Dryer Case Study Team

One of the strengths of the Scaling Readiness approach is that innovation packages are formulated and diagnosed for different scaling contexts. This was acknowledged by the flash dryer project team and was generally appreciated by scaling project teams who used Scaling Readiness. Since each country has its particular context and related bottlenecks, strategies must be adapted to each context to define the most appropriate way to achieve scaling. For example, the teams appreciated analysis required to identify the most appropriate heat generation system for each country to reduce fuel consumption and contribute to the energy efficiency of cassava drying.

To determine the degree of maturity or readiness of the innovations and the level of innovation use, it is necessary to have a deep knowledge of the context. In this regard, one of the lessons learned from the flash dryer case was that it is not enough to carry out this analysis only at the beginning of the project, but that periodic diagnoses must also be carried out, since the context is dynamic and changing, and *emerging* bottlenecks can arise.

Collecting information to design strategies and monitor scaling progress was a challenge in the case study project. Scaling Readiness collects this information through electronic surveys, but it was found that most of the project partners were unresponsive. Some were very busy or did not believe they had the capacity to complete an electronic survey. The challenge will be to develop mechanisms that capture as much information as possible while being user-friendly for the project partners. Collecting information during project meetings or as part of workshops seemed to be more promising in terms of response rates and data quality.

In the course of project implementation, differences emerged between countries in terms of the distribution of responsibilities between processors, equipment manufacturers, and the project team. This dynamic also was felt at the level of co-investment realized and the distribution of financial risks. In DR Congo, cassava processors were confident in the market for cassava flour, which is a staple food product in this country, and, therefore, were more willing to invest in flash dryers

and take the financial risks without having a formal agreement. In Nigeria, the market for cassava flour is not functioning smoothly due to a combination of factors, such as low availability of cassava roots at competitive prices for flour production, high processing costs due to low energy efficiency of current flash dryers, and a mismatch between production capacity of cassava processors and demand from large buyers. Consequently, cassava processors were less confident to bear investment risks, with the majority preferring to wait for successful implementation of the flash drying innovation before investing themselves. In Latin America, investment costs (and financial risk) were significantly higher due to higher labor costs and other constraints. In addition, the market for cassava flour is not mature yet. Consequently, cassava processors were not willing to fully take on the investment risks and required that equipment manufacturers, or the flash dryer Scaling Project, offer guarantees against construction cost overruns and potential financial underperformance of the flash dryer system. This led to negotiations and written agreements in the form of a sales contract between the cassava processor and the equipment manufacturer.

These examples underscore the idea that scaling projects always entail financial risk-taking, considering that innovations, by nature, are not yet fully proven with guaranteed return on investment. Therefore, a key bottleneck is finding agreement between project partners who will take on responsibility for these risks. One option to manage this is to identify and select early in the project private partners who are in a position to accept the risks. That is, partners with financial capacity for investment, confidence in the benefits of the innovation, and access to technical expertise to remedy emerging challenges before and after the construction and delivery of the equipment.

3.4.2 Reflections on the Use of Scaling Readiness in the RTB Scaling Fund

We offer four main reflections:

1. When the first batch of Scaling Fund projects was selected and approved – early 2018 – the Scaling Readiness approach was still under development. Although the basic principles and concepts of Scaling Readiness were defined, tested, and validated, there were no clear guidelines and workflows that supported its application with partners in controlled conditions – the Scaling Fund projects. Those guidelines and capacity development materials were developed in parallel to Scaling Fund project implementation, which sometimes resulted in confusion (e.g., What is an innovation? What is an innovation package? How to measure and document innovation readiness and innovation use? How to deal with gender and diversity among beneficiaries?). This lack of development also meant a steep learning curve between the Scaling Readiness team and Scaling Fund project teams. The second and especially third batches of Scaling Fund projects

benefitted from those learnings, resulting in a more organized and tailored application of Scaling Readiness. A very concrete spin-off of such learning is the development of a gender-responsible scaling tool for identifying relevant diversity in relation to scaling ambitions (which is currently being designed and tested for use in combination with Scaling Readiness).

2. Scaling of innovation (increasing innovation use) is very different from processes related to designing, testing, and validating the innovation through basic and applied research (improving innovation readiness). For doing the scaling, different skills and competencies, language, organizational space, and incentive structures are required. Many of these skills are very different from those that scientists obtain during their PhD trajectories and require competencies related to being opportunistic, taking risks, and negotiating with scaling partners. After the first year of Scaling Fund implementation, we decided that projects had to identify dedicated scaling champions and Scaling Readiness monitors to ensure that scaling projects were not treated and organized in the same way as science projects. Having dedicated scaling champions and Scaling Readiness monitors clarified the division of tasks and responsibilities in the RTB scaling projects. In addition, capacity development on innovation and scaling processes was very much appreciated by the Scaling Fund project teams.

3. Having senior staff in charge of scaling project design, implementation, and decision-making was not always compatible with best practices for managing scaling projects. The time and responsibilities of senior staff are often fragmented, meaning they need to juggle to a broad variety of science, management, and leadership demands and expectations. Furthermore, scientists are often not on the ground in the context where scaling is desired. The environments in which the cassava flash dryer and other RTB Scaling Fund projects operate are very dynamic and require ongoing *navigation* and *re-strategizing*, which requires operational knowledge. One of the opportunities we see here is to decentralize management and decision-making in scaling projects so that on-the-ground scaling champions can act in a flexible manner based on the analysis and data provided by Scaling Readiness monitors. We have seen that Scaling Fund projects where such a decentralized model for decision making was applied seemed more successful in capitalizing on emerging opportunities and navigating change.

4. When starting Scaling Fund implementation, it was expected that in the first months of the projects, research and scaling partners would go through a cycle of Scaling Readiness steps and start implementing and monitoring their scaling strategies and action plans. This turned out to be very different in actual practice. First, the process of sense-making and capacity development took much longer than expected. Many of the project teams had very different or unclear ideas about their "innovations" and struggled to think critically about what scaling pathways and mechanisms would be required to actually make their products, services, or tools available to end users. Second, working with co-investing scaling partners was essential but also difficult. Scaling partners – especially when they are co-investing – are very deliberate on whether and how

to engage and need to see added value in investing their time and resources in the partnership. As in the flash dryer case, scaling partners may propose risk-sharing strategies – or pull out altogether – if the investment conditions change. It made us realize that the 2-year Scaling Fund projects were essentially about finding common ground between research and scaling partners and creating the space for negotiation, adaptation, and integration that is needed before the actual scaling can happen.

3.5   An Outlook on the Broader Use of Scaling Readiness

The CGIAR Research Program on Roots, Tubers and Bananas has pioneered support and investment in the development and implementation of scaling strategies and partnerships to catalyze the scaling of its innovations. The consequent investment in the Scaling Fund has been timely. The entire CGIAR (2020) is reorganized around an impact-oriented approach, and *scaling* will figure prominently among the different parts of the organization.

Several of the Scaling Fund and Scaling Readiness principles could be embedded in a new way of doing business in CGIAR.

1. *Keep track of innovation readiness and innovation use.* Tracking these elements can support monitoring, prioritization, and resource allocation. Doing this in an evidence-based and structured way can increase transparency, facilitate decision-making, support resource mobilization, and demonstrate return on investment at both the innovation package and portfolio levels. By portfolio level, we mean the management of a broad number of innovation packages and making decisions on which ones to prioritize.
2. *Combine innovation readiness and innovation use in one framework*. With this idea, international organizations, such as the CGIAR, can better link research and development as part of its mandate. Within such a framework, science and applied research focusses on improving innovation readiness in close collaboration with expected beneficiaries and innovation partners, and – once proven to work – scaling can focus on improving innovation use with scaling partners.
3. *Capitalize on the promise of the Scaling Fund co-investment model where research and scaling partners jointly commit funds and capacities to preparing the innovation*. This recommendation would provide a more level playing field between partners and create a higher likelihood that innovations are adapted to become of real value to scaling partners. During the initial stages of sense-making and finding agreement on what the innovation package looks like and which bottlenecks should be prioritized, a *safe incubation space* – such as provided in the Scaling Fund – serves to reduce risk and incentivize partners to find common ground.

4. *Work to create an ecosystem in which the rules and cultures of scaling are different than what people are accustomed to.* This made us realize that the appropriate use of novel approaches such as Scaling Readiness and working in an impact-oriented manner needs to go hand in hand with organizational culture change, capacity development and new incentive structures that reward project teams to prioritize work on bottlenecks in innovation packages. Similarly, strategic options such as reorientation, postponing, relocating, or stopping an intervention when innovation and scaling bottlenecks cannot be overcome should be encouraged, rather than be labelled as a failure as it can avoid wasting of valuable R4D resources.

5. *Ongoing efforts to make Scaling Readiness more sensitive to gender and social differentiation will need to continue.* It seems promising to explore whether and how innovation packages, and scaling strategies can be tailored to groups that are at risk of being excluded.

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